INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/17335

A.	CLASSIFICATION OF SUBJECT MATTER

IPC(7)   :   G01V 1/28
US CL   :   367/41, 46, 43, 38, 40, 189

According to International Patent Classification (IPC) or to both national classification and IPC

B.	FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
        U.S. : 367/41, 46, 43, 38, 40, 189; 181/111, 113, 114

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C.	DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01/61379 A2 (Jeffryes) 23 August 2001 (23.08.2001), Page 4, Line 15 to Page 8, Line 20; Page 10 to Page 16, Figs. 9-10	1-9
Y	US 5410517 (Anderson) 25 April 1995 (25.04.1995) , Figs. 3,5, abstract; Column4, ine 20 to Column 5, Line 20; Column 6, Line 10 to Column 7, Line 65; Columns 8, 12-14	1-9
A	US 5721710 (Sallas et al) 24 February 1998 (24.02.1998)	1-9
A	US 6842701 (Moerig, et al) 11 January 2005 (11.01.2005)	1-9
A	US 5715213 (Allen) 3 February 1998 (03.02.1998)	1-9
A	US 5703833 (Allen) 30 December 1997 (30.12.1997)	1-9
A	US 5550786 (Allen) 27 August 1996 (27.08.1996)	1-9

☐ Further documents are listed in the continuation of Box C.	☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier application or patent published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 November 2005 (23.11.2005)	0 3 JAN 2006
Name and mailing address of the ISA/US	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Scott Hughes ꓯ Hughy Telephone No. 571-273-6983

Form PCT/ISA/210 (second sheet) (April 2005)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: J. PAUL PLUMMER EXXONMOBIL UPSTREAM RESEARCH COMPANY P.O. BOX 2189 HOUSTON, TX 77252-2189	**PCT** WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43*bis*.1)

	Date of mailing *(day/month/year)*	**0 3 JAN 2006**

Applicant's or agent's file reference 2003UR020	FOR FURTHER ACTION See paragraph 2 below

International application No. PCT/US04/17335	International filing date *(day/month/year)* 03 June 2004 (03.06.2004)	Priority date *(day/month/year)* 11 August 2003 (11.08.2003)

International Patent Classification (IPC) or both national classification and IPC

IPC(7): G01V 1/28 and US Cl.: 367/41, 46, 43, 38, 40, 189

Applicant

KROHN, ET AL

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1. This opinion contains indications relating to the following items:

☒ Box No. I Basis of the opinion

☐ Box No. II Priority

☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

☐ Box No. IV Lack of unity of invention

☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

☐ Box No. VI Certain documents cited

☐ Box No. VII Certain defects in the international application

☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis(b)* that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Date of completion of this opinion 23 November 2005 (23.11.2005)	Authorized officer Scott A. Hughes Telephone No. 571-272-6983

Form PCT/ISA/237 (cover sheet) (April 2005)

	International application No.
WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	PCT/US04/17335

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing

   ☐ contained in the international application as filed.

   ☐ filed together with the international application in electronic form.

   ☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Form PCT/ISA/237(Box No. I) (April 2005)

	International application No.
WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	PCT/US04/17335

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-9	YES
	Claims	none	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-9	NO
Industrial applicability (IA)	Claims	1-9	YES
	Claims	NONE	NO

2. Citations and explanations:

Please See Continuation Sheet

Form PCT/ISA/237 (Box No. V) (April 2005)

<table>
<tr><td></td><td>International application No.
PCT/US04/17335</td></tr>
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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

Supplemental Box
In case the space in any of the preceding boxes is not sufficient.

V. 2 Citations and Explanations:
Claims 1-9 lack an inventive step under PCT Article 33(3) as being obvious over Jeffryes in view of Anderson.

With regard to claim 1, Jeffryes discloses a method of operating a plurality of N seismic vibrators simultaneously with continuous sweeps, and separating the seismic response for each vibrator (abstract). Jeffryes discloses loading each vibrator with a unique continuous sweep consisting of M (greater than or equal to) N segments, the ith segment being of the same duration for each vibrator (Page 5, Line 4 to Page 6, Line20, Pages 7-8,10). Jeffryes discloses activating all vibrators and using at least one detector to detect and record the combined seismic response signals from all vibrators (Page 10). Jeffryes discloses selecting and recording a signature for each vibrator indicative of the motion of that vibrator (Page 10, Line 8 to Page 11). Jeffryes discloses parsing the vibrator motion record for each vibrator into M shorter recorders, each shorter recording coinciding in time with a sweep segment (Page 11, Lines 1-20). Jeffryes discloses padding response signals but does not disclose padding the shorter records of the vibrator motion record to substantially extend its duration by one listening time (Pages 18-19). Anderson discloses padding seismic signals by one listening time when using a continuous sweep consisting of M segments. (Column 4, Lines 20 to Column 5, Line 20; Column 6, Lines 10 to 60; Column 8; Columns 12-14). It would have been obvious to modify Jeffryes to pad the signals with time up to the listening time as taught by Anderson in order to be able to process the data with a correlation reference sequence. Jeffryes discloses forming an M by N matrix whose element Sij(t) is the vibrator motion record as a function of time of the ith vibrator and jth sweep segment (Pages 5-7; 10-11, 14-16, 20-22). Jeffryes discloses parsing the seismic data record from above into M short records, each shorter record coinciding in time with a padded shorter record of vibrator motion from step d). Jeffryes discloses forming a vector d of length M whose element di is the ith shorter data recorder from the preceding step. Jeffryes discloses solving for Ej(f) the system of M linear equation in N unknown SE=D. Jeffryes discloses inverse Fourier transforming Ej(f) to yield ej(t) (Pages 10-11, 14-16, 19-20).

With regard to claim 2, Jeffryes discloses that each sweep segment is selected from linear sweep-design (Page 10, Lines 5-15).

With regard to claim 3, Jeffryes discloses that all of the N unique continuous sweeps are identical except for the phase of their segments (Page 10, Lines 15-25).

With regard to claim 4, Jeffryes discloses that all N segments are identical except for phase. Jeffryes discloses constructing a reference sweep by starting with a preselected reference segment, then advancing the segment 360/M degrees in phase to make the second segment, then advancing the phase 360/M degrees more to make the third segment, and so on to generate M segments. Jeffryes discloses constructing a first sweep by advancing the phase of the first segment of the reference sweep by 90 degrees. Jeffryes discloses constructing a second sweep by advancing the phase of the second segment of the reference sweep by 90 degrees and so on until all N sweeps are constructed (Page 7).

Form PCT/ISA/237 (Supplemental Box) (April 2005)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
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Supplemental Box
In case the space in any of the preceding boxes is not sufficient.

With regard to claim 4, Anderson discloses that all N segments are identical except for phase. Anderson discloses constructing a reference sweep by starting with a preselected reference segment, then advancing the segment 360/M degrees in phase to make the second segment, then advancing the phase 360/M degrees more to make the third segment, and so on to generate M segments. Anderson discloses constructing a first sweep by advancing the phase of the first segment of the reference sweep by 90 degrees. Anderson discloses constructing a second sweep by advancing the phase of the second segment of the reference sweep by 90 degrees and so on until all N sweeps are constructed (abstract; Columns 4, 6).

With regard to claim 5, Anderson discloses that each unique continuous sweep has a duration in time sufficiently long to collect all seismic data desired before relocating the vibrators (Columns 4, 6).

With regard to claim 6, Jeffryes discloses that the vibrator signature record for each vibrator is a weighted sum or ground force record of the motion of that vibrator (Page 4, Lines 5-14; Pages 10-12).

With regard to claim 7, Jeffryes discloses that M=N and that the system of linear equation SE=D is solved by matrix methods comprising the steps of deriving a separation and inversion filter by inverting matrix S then performing the matrix multiplication (Page 8, Lines 1-5; Pages 11-19).

With regard to claim 8, Jeffryes discloses that SE=D is solved by matrix methods and the method of least squares comprising the steps of deriving a separation and inversion filter of the form F=(S*S)-1S* then performing the matrix multiplication FD (Page 8, Lines 1-5; Pages 11-19).

With regard to claim 9, Jeffryes discloses that each segment has a duration that is at least as long as the seismic wave travel time down to and back up from the deepest reflector of interest (Page 1).

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